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RESEARCH OF THE MAIN PARAMETERS OF THE TECHNOLOGICAL PROCESS OF ELECTRIC CONTACT WELDING AT THE RESTORATION OF MACHINE PARTS

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The object of research is the process of restoring lancet cultivator paws by electrocontact welding of their working parts, the process connection with technological processing parameters and the physical and mechanical properties of their material.

One of the most problematic places in the method of electrocontact welding when restoring the working organs of tillage machines is the lack of optimal operating parameters of this technological process of strengthening the cutting elements of working organs working in the soil-aggressive environment.

Optimal parameters of electrocontact welding method of the metal mesh to the worn-out surface of the part make it possible to increase the strength of the material of the recovered parts, improve its physical and mechanical properties and increase their service life, and to reduce the magnitude and irregularity of wear.

Theoretical studies of the main parameters of the technological process are carried out using the equations of mechanics of deformed bodies with their own physical and mechanical properties.

In the course of the study, a steel mesh made of high-strength steel is used, and metal powders are used as a filler material, which strengthened the material of the component and increased its life.

Increased wear resistance of the restored parts is obtained. This is due to the fact that with this technological process, the formation of the surface relief takes place with the formation of depressions on it, which retain the lubricant, which ensures a higher coating resistance.

Due to this, it is possible to obtain a coating of parts with a thickness of up to 1.5 mm, an increase in their durability of 1.45–2.1 times and a decrease in wear intensity of 1.65 times compared to new cultivator paws.

Keywords: electrocontact welding, technological process, abrasive wear, adhesion strength, coating properties.

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MECHANICS

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ANALYSIS OF EFFICIENCY OF DECK DIVERCE MASKING FROM DISTRIBUTION-DIVERSION GLAIDERS BY A FORMABLE EMBODY BUFFER ZONE

page 10–15

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The object of research is the process of elastic interaction of an ultrasonic beam with a cylindrical module enclosing the airplane in the form of two circular shells of the same length coaxially connected by their ends, the hermetical gap between them filled with liquid.

One of the problematic areas of the study is that the dislocation of deck aviation in the open waist plane allows the means of detecting the suborbital and atmospheric reconnaissance of the enemy to determine undefined not only the initial coordinates but also its coordinate functions for the entire period of subsequent trajectory travel. Finally, the on-board glider equipment, taking this information as the original one, makes it possible, with anticipation, accurately, to fire at the theoretical trajectory of motion, thereby increasing the probability of hitting the target. Therefore, it is necessary to ensure 100 % masking of deck aviation at open launch positions. This will significantly reduce or completely eliminate and improve the efficiency and life-span of the aircraft as a whole.

It is shown that, when the case is subjected to symmetrical oscillations, which greatly exceed the resistance to antisymmetric vibrations, the sound permeability of the case elements will increase solely by bending vibrations. It is revealed that the «acoustic transparency» of the device case serves as an intensive transfer of the sound energy of the bending waves of the case and completely depends on the frequency of the acoustic radiation, as well as the incidence angles. Thus, by creating a circular or ellipsoidal enclosing cylindrical module in the form of two circular shells filled with liquid, it will be possible to quickly disassemble and place it over another object in a matter of hours.

Keywords: angle of aberration, ultrasonic radiation, resonance of wave coincidence, caustic zones, enclosing surface.

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INVESTIGATION OF THE INFLUENCE OF GRAVITATIONAL FORCES ON THE PROCESS OF DISPLACEMENT OF VISCOPLASTIC FLUIDS

page 15–21

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The object of research is a numerical simulation of the process of two-dimensional two-phase filtration of viscoplastic oil and water, taking into account the gravitational forces, some properties of liquids, as well as relative phase permeabilities and capillary forces.

As is known, the problems of multiphase filtration have specific features. Therefore, there is a need to develop difference schemes in adaptive grids that reduce the artificial viscosity and oscillation of the numerical solution. They also make it possible to obtain acceptable results with a small number of nodes in the computational grid.

To take into account the singularities of the solution, a difference-iteration method is used in moving grids. Based on the computational experiment, the influence of the initial pressure gradient and gravity on the displacement process is investigated.

Economical difference schemes that combine the advantages of explicit and implicit schemes are constructed and make it possible to reduce the two-dimensional problem to a chain of one-dimensional problems. A difference-iterative method is also proposed in moving grids for solving two-dimensional (axisymmetric) non-stationary filtration problems of anomalous liquids, by means of which an iterative process is constructed to find the distribution of water saturation.

The carried out calculations to determine the influence of gravity on the displacement process have shown that at $z=0$, even at low productive-bed thicknesses, gravitational forces influence the displacement process. And over time this influence increases: if at the time $t=0.08$ on the circuit the difference of water saturation was 0.0077; at $t=0.24–0.0122$, then at $t=1.04$ it becomes equal to 0.0292.

It is shown that when modeling the process without taking gravity into account it is expedient to simplify the geometry of the filtration region, i. e., to consider a plane-radial flow in view of the considerable simplicity of the calculations.

The developed algorithms can be used for hydro-gas dynamic calculations related to the development and operation of oil fields containing anomalous oil.

Keywords: gravitational forces, variable direction method, locally one-dimensional schemes, adaptive grid, viscoplastic fluid.

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MATERIALS SCIENCE

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DEVELOPMENT OF FIRE RESISTANT COATING FOR THE PROTECTION OF ELECTRICAL CABLES OF FIRE IN A CLOSED SPACE

page 22–28

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The object of research is the composition of the fire-resistant swelling coating.

The main problem of electric cables fire protection in a confined space is a high concentration of toxic substances in the composition of combustion products, which makes it difficult fire extinguishing works. This is due to the fact that the cables polymer insulation (polyethylene, polyvinyl chloride) and traditional flame retardant coatings based on epoxy and phenolic resins contain potentially hazardous substances. These substances during combustion are form toxic compounds (chlorine, carbon monoxide, hydrogen cyanide).

Experimental studies of various compositions based on the silicone resin were carried out to solve the problem of creating a non-toxic fire-resistant swelling coating. This has allowed to develop optimal recipe of fire-resistant coating the components of which do not emit nontoxic substances under fire conditions.

The original test procedure for coatings for fire resistance, with exposure to samples of the open flame of a gas burner was applied during the study that is more consistent with the conditions of a real fire. The temperature on a back surface of the sample was controlled during the experiments.

The functional dependence of the fire-resistant properties of coatings on the concentration of components was obtained

The optimal composition of the fire-resistant swelling coating was obtained, which contains: ammonium polyphosphate 65 ± 2 %; pentaerythritol – 15 ± 2 %; melamine – 10 ± 2 %; aluminum and magnesium hydroxides – 5 ± 1 % by fine fillers weight.

The proposed composition of the fire-resistant coating content has an increased content of ammonium polyphosphate, which mainly determines the good flame retardant properties. The developed composition as a whole meets the requirements for fire resistance and has advantages over similar fire-resistant compounds in terms of toxicity level.

Keywords: non-toxic fire-resistant intumescent coating for the protection of cable insulation, composition components, test methodology.

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RESEARCH OF MINERALOGICAL COMPOSITION, STRUCTURE AND PROPERTIES OF THE SURFACE OF UKRAINIAN ASH MICROSPHERES

page 28–34

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The progressive trend in material-intensive industries is the use of industrial waste as raw materials suitable for the industrial industry. One of such wastes is ash microspheres, which are a by-product of the operation of solid-fuel thermal power stations. Comparison of the properties of the ash microspheres of different manufacturers by their physicochemical, morphological, dielectric and other properties allows to comprehensively evaluate each sample of the material. On the basis of this evaluation, it is possible to select the assignment of ash microspheres, which would maximally effectively use their potential in the composition of the composite material. For the study, ash microspheres obtained at various TPSs of Ukraine: Trypillia, Burshtyn, Kurakhove, Kryvyi Rig and Prydniprovska are selected.

As a result of studies of the mineralogical composition, structure and properties of ash microspheres, it is found that the latter are a high-temperature material with a high temperature resistance. The specific surface of the ash microspheres is comparatively small and depends, in the main, on the mineral constituent of the coal rock. Thus, for the investigated materials the effective specific surface area varies within the limits of 1.7–2.3 m^2/g.

As for the mineralogical composition, the predominant crystallophase is represented, mainly mullite (91–98 %). An exception in this case is the ash microspheres of the Kurakhove TPS, in which mullite is 43 %. Also, a significant proportion of the mineralogical composition of the ash microspheres of the Kurakhove TPS is opal cristobalite (37 %).

Also, the thermal conductivity of ash microspheres of selected TPSs in Ukraine is investigated. The highest coefficient of thermal conductivity is the ash microspheres obtained from the Trypillia and Burshtyn TPSs (0.190 and 0.184 W/(m·K), respectively), and the lowest – Prydniprovska TPS.

Ash microspheres serve as a promising material both from the point of view of processing coal waste and from the point of view of using it as filler for building materials with increased thermal insulation properties. From this it follows that ash microspheres allow to significantly expand the scope of their use, including in the construction industry.

Keywords: ash microspheres, specific surface, mineralogical composition, powdery material, amorphous phase.

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CRYSTALLINE STRUCTURE ANALYSIS OF Ba_3WO_6 COMPOUND

page 34–39

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The object of research is the crystal structure of Ba_3WO_6 compound, which can be used in metal porous cathodes for rocket engineering, as an ionic conductor and also in solid-state lighting devices. One of the most problematic places is the availability of a variety of information on the crystal structure of this compound. So in pdf-2 database for 2004 there are seven diffraction spectra of different quality, obtained for Ba_3WO_6 compound synthesized by different methods.

The research uses the pdf-2 database for 2004, the HiphScore-Plus 3.0 program, and the generated spectrum 00-033-0182, which has a high quality of survey.

The X-ray phase analysis doesn't reveal the presence of several phases in the investigated compound, which are represented in the state diagram. So it is concluded that the compound is single-phase.

It is found that the investigated spectrum belongs to the structural type $Ba_{11}W_4O_{23}$. Positions Ba1 (8b), Ba2 (48f), W2 (16c), O2 (96g), O3 (96h), O4 (96g) have vacancies. Due to the existing vacancies, the stoichiometric composition of the compound from the structural type $Ba_{11}W_4O_{23}$ is shifted as $Ba_{84,46}W_{31,07}O_{189,08}$. Such vacancies provide ionic conductivity of the compound.

It is found that the compound belongs to the cubic system, the space symmetry group Fd-3m, has a constant crystal lattice of 17.1690 (4) A°. The disagreement factor is $R=5.43404$. The displaced stoichiometric composition can mean that this compound has a significant area of homogeneity, the boundaries of which can be the subject of further research.

Keywords: X-ray diffraction analysis, pdf-2 database, Rietveld method, $Ba_{84,46}W_{31,07}O_{189,08}$.

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ELECTRICAL ENGINEERING AND INDUSTRIAL ELECTRONICS

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ANALYSIS AND COMPARISON OF METAL-OXIDE SURGE ARRESTER MODELS

page 40–46

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The objects of the research are: full and simplified dynamic models of surge arresters, as well as the model of surge arrester in the form of a nonlinear resistor. For the simulation of the voltage-current characteristics, in the latter case the approximation was used, describing by one expression both switching and lightning surge domain. At the present time, the traditional approach is applied for the study of surge arrester models. The surge arrester model is connected

in series with a current source of a given waveform and amplitude. Then, the residual voltage is computed on the surge arrester model. The simulation results are compared with the corresponding passport values and a conclusion is made about the applicability of this model.

In practice, as a result of lightning activity, surge arresters are exposed to impulse voltage waves. The use of voltage impulses in comparing the models of metal-oxide surge arresters has not been studied sufficiently yet.

Analysis of different surge arrester models subjected to the lightning current impulses was carried out. The residual voltage, which arises in this case on the surge arresters, was computed. The results obtained with a nonlinear resistor do not differ from the results obtained with the full model by more than 5.74 %, and from the results obtained with the simplified model by more than 5.67 %. Analysis of the same surge arrester models subjected to the lightning voltage impulses was carried out. The residual voltage, which arises in this case on the surge arresters, was computed. The results obtained with a nonlinear resistor do not differ from the results obtained with the full model by more than 9.41 %, and from the results obtained with the simplified model by more than 7.85 %.

When making final choice of a particular surge arrester model, it is preferable, because of the need for a certain safety factor, to choose model which gives largest residual voltage values when the voltage impulses are applied. It has also been established that even when modeling a surge arrester in the form of a nonlinear resistor, but taking into account the approximation of its voltage-current characteristic by one expression, the results do not exceed the limits of engineering accuracy.

Keywords: model of surge arrester, current impulse, voltage impulse, voltage-current characteristic.

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DESIGN OF CONCEPTION ON LIGHTNING MONITORING SYSTEM FOR STRIKES TO STRUCTURES

page 47–59

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The object of research is the monitoring system (MS) for lightning, which strikes specific objects or happening nearby. It is based on the use of regular (not high-speed) video cameras. Among drawbacks of some existing MS having video capturing of strike position, one can indicate that in automatic setting modes they are able to record comparatively reliably only discharges including continuous current component. Also, the triggering to start saving of video fragment with lightning into memory and transmission to server is provided usually by optical sensor only. Other sensors are used rarely or their characteristics are not well substantiated. High-speed cameras are also utilized sometime, but this is expensive and usually related to research projects. Two variants of MS conception were worked out during the study – complex and simplified. It is suggested to use additional sensors (electric and magnetic field, acoustic) for reliable triggering of MS and also several video cameras. In both variants of MS, for extraction of only frames containing captured lightning strikes from the whole recorded video row, it is suggested to use software based on computer vision library (Open CV).

Characteristics of all sensors are substantiated and recommended, in particular:

– video cameras – IP-type, 25...50 fps, 1080p or better;

– optical sensor – sensitivity range 0.4...1 μm, time resolution – 1 μs, distance – up to 500 m;

– «slow» electric field antenna – electronic type, 0.1...10 Hz;

– «fast» electric field antenna – rode or plate type, 1 kHz... 5(20) MHz;

– magnetic field registration – compact ferrite antenna, 3...30(100) kHz;

– thunder recording – capacitor microphones at 0 to 1...2 kHz.

Experimental laboratory tests are carried out regarding designed optical sensor performance by using impulse current, which have parameters corresponding to actual lightning.

Keywords: lightning video registration, lightning monitoring, lightning monitoring system, thunderstorm warning system.

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DEVELOPMENT OF A METHOD FOR MEASUREMENTS OF THE PARAMETERS OF THE EXTERNAL MAGNETIC FIELD OF TECHNICAL MEANS

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The object of research is methods and means of measuring the parameters of the external magnetic field of technical objects. One of the most problematic areas of existing methods for measuring the magnetic moments of sources of an external magnetic field is the presence of a significant methodological error. For magnetometric methods, its value is 10 %, for integral 20–30 %, which is due to the imperfection of the theoretical foundations of the method.

In the course of the research, methods of analytical representation of an external magnetic field and its modeling, magnetometric methods for measuring the strength of a magnetic field, methods for solving systems of algebraic equations, and methods for matrix algebra are used.

A method has been developed for measuring the components of the dipole magnetic moments of sources of an external magnetic field in three orthogonal directions. The method ensures the measurement of the dipole component and eliminates the influence on the measurement results of the multipole interference of the spatial harmonics of the magnetic field in the interference of the fifth harmonic. Due to this, a significant reduction in the methodical measurement error is ensured. It is determined that the methodical error in measuring the components of the magnetic moment M_x, M_y, M_z is 0.381–1.278 %. The accuracy of measurement in two overall dimensions increases by an order of magnitude in comparison with the analog. The sensitivity of the measuring channels to the useful signal is increased by 2 times.

Keywords: external magnetic field, magnetic field strength, dipole magnetic moment, methodical error, induction sensor.

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TECHNOLOGY AND SYSTEM OF POWER SUPPLY

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ANALYSIS OF ENVIRONMENTAL, LEGISLATIVE AND TECHNOLOGICAL ASPECTS OF THE CHOICE OF NON-AQUEOUS WORKING BODIES FOR POWER PLANTS

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In the conducted researches there is a task of a choice of a working body for a heat power circuit of power plants on non-aqueous working substances with possibility of considerable increase of power efficiency of a cycle and safety of operation of plants in view of restrictions of the Montreal and Kyoto protocols. In an experimental study of the possibility of using fluorocarbon working bodies and SF_6 as working bodies of energy cycles, positive results have been obtained both in terms of increasing the safety of operation of power plants and increasing their reliability, and in terms of energy efficiency. However, their use as working bodies was delayed by the extremely long lifetime in the atmosphere by the Lifetime criterion.

When calculating material balances of fluorocarbons and SF_6 gas in the atmosphere based on the new IPCC-2013 data, a discrepancy of four orders of magnitude of the Lifetime criterion is found with the initial data given by IPCC-94. Based on these data, restrictions are introduced on the use of these substances within the framework of the commitment of the countries participating in the Kyoto Protocol to the UNFCCC. This gives grounds for the use of fluorocarbons and SF_6 gas without restrictions on the basis of the greenhouse hazard, since the lifetime of these substances in the atmosphere does not exceed 2 years.

The use of fluorocarbons and SF_6 gas as working bodies of energy cycles will significantly reduce energy consumption in the refrigeration industry and will significantly increase the efficiency in generating electricity at TPPs and NPPs, while reducing energy consumption by 20–25 %.

Keywords: power plant, working bodies of energy cycles, stability of substances, sulfur hexafluoride.

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